FOREST PRODUCTS

LABORATORY

MADISON, WIS.

C. P. WINSLOW

THE FOREST PRODUCTS LABORATORY

The Forest Products Laboratory, the first of its kind in the world, was established in 1910 by the Forest Service, United States Department of Agriculture, in cooperation with the University of Wisconsin. Thru the results of its research experiments and commercial tests, it has come to be recognized as a source of authoritative information on the mechanical and physical properties of commercial woods, the principles underlying the kiln drying of wood, its preservative treatment, its use for the production of paper and wood pulp, and its possibilities as the source of chemical properties.

Today the laboratory is making every effort to turn its store of information and its facilities to the most effective service of the Government and its Allies in the war.

Some of its more conspicuous accomplishments of military value are the determinations of the strength values of the principal woods which could be used for airplanes, the development of a satisfactory method of kiln drying airplane stock without injury to its strength, the evolution of several new types of airplane parts, the discovery of suitable glues for airplane use, the conducting of informative tests on material submitted by aircraft, army vehicle and box manufacture, and the drafting of specifications for the War Department covering many of the war time uses of wood.

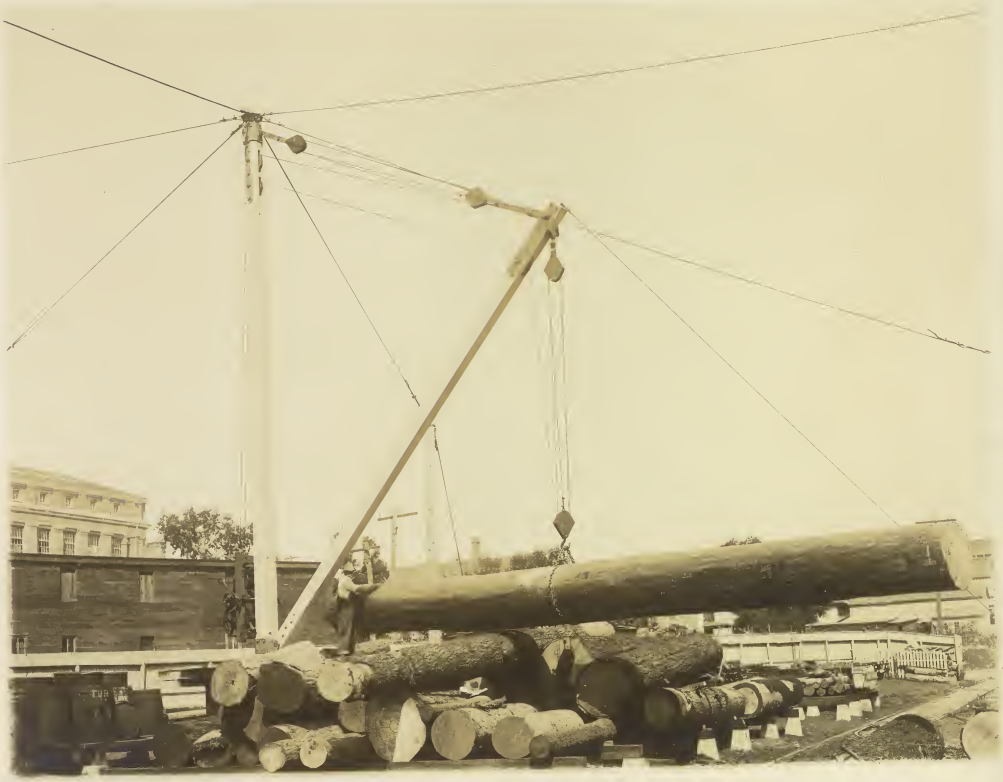
The present personnel of the laboratory includes over two hundred fifty technical men and assistants. The building shown here, which sufficed for normal activities, has been supplemented by two of equal size to meet the needs of the present investigative program.

THE LABORATORY YARD

The material with which the several sections of the laboratory conduct their experiments is received in many forms. Some of it is in the form of finished commercial products. A large part of it is in the raw state. The derrick is here shown unloading a redwood log 40 feet long and 60 inches in diameter. This will be sawed into lumber and used in kiln drying experiments and mechanical tests which will in determining the suitability of this species for airplane construction.

THE LABORATORY YARD

The material with which the several sections of the laboratory conduct their experiments is received in many forms. Some of it is in the form of finished commercial products. A large part of it is in the raw state. The derrick is here shown unloading a redwood log 40 feet long and 40 inches in diameter. This will be sawed into lumber and used in kiln drying experiments and mechanical tests which will aid in determining the suitability of this species for airplane construction.



A LABORATORY BUILDING

This building, recently completed by the Agricultural Engineering Department of the University of Wisconsin, was made given over to the Wisconsin Memorial Section of the Wisconsin Engineer. A large portion of the roofs of airplane material will be carried on here.

A LABORATORY ANNEX

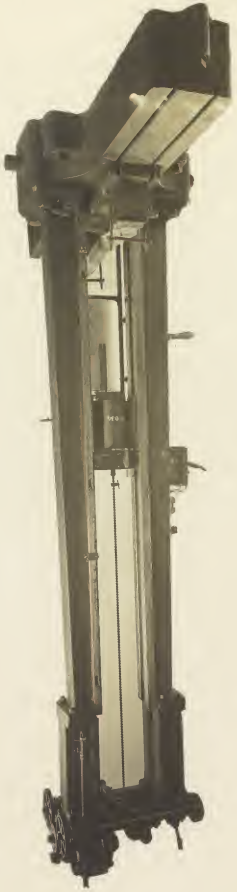
This building, recently occupied by the Agricultural Engineering Department of the University of Wisconsin, has been given over to the Timber Mechanics section of the Forest Products Laboratory. A large portion of the tests of airplane material will be carried on here.

3

Fig. 1. Femur of Dinornis robustus.

IMPACT TESTING MACHINE

A 50-lb. hammer is dropped upon the specimen at the center of the span, first from a height of 1", next 2", etc., up to 10", then increasing 2" at a time until failure occurs. Data thus obtained are indicative of the resistance of various species to shock.

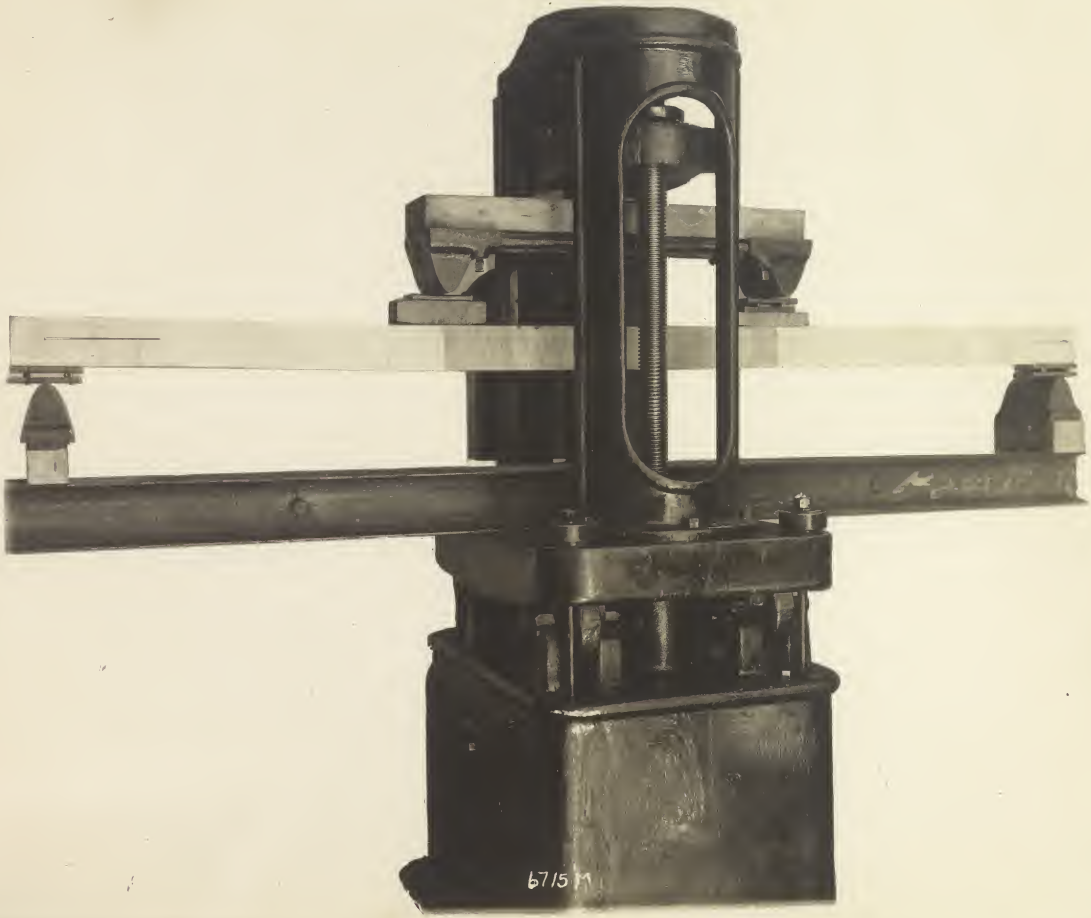


Aluminum Pratt truss

Aluminum-alloy pratt point load-
ing device, over 1 span of 72 in
ches. The specimen undergoing test
is a box beam with diagonal flanges
and pratt-pattern vanner sheets.

STATIC BENDING TEST

Illustrating third point loading method, over a span of 72 inches. The specimen undergoing test is a box beam with spruce flanges and birch-poplar veneer cheeks.

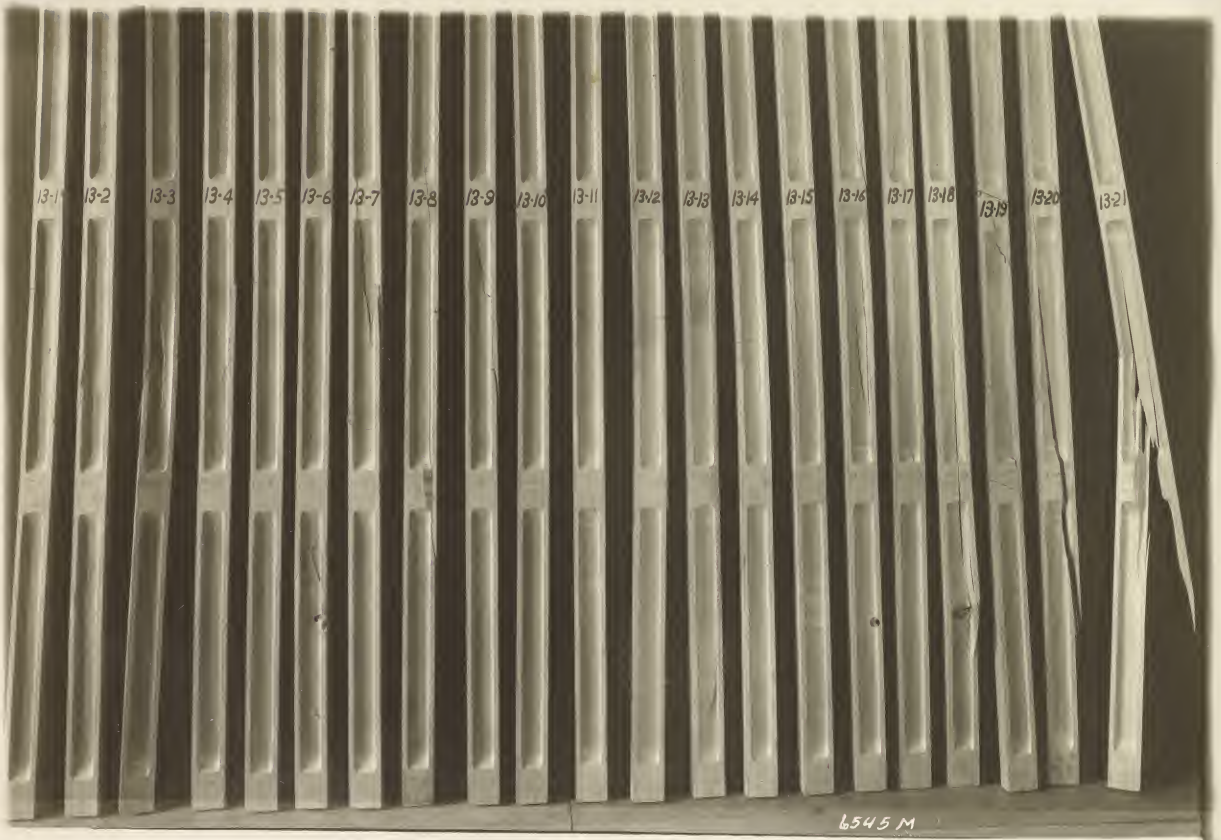

6715

[illegible]

[illegible]

AIRPLANE WING BEAMS

These solid I beams comprise one of three groups tested to determine manner of failure under third point loading. The other two groups were of veneer-web and box beams.



Project No 228-3.

I-BEAM SECTION, Solid. Series No. 13.

Manner of Failure.

Forest Products Laboratory. May 13, 1918 Madison. Wis.

DOUGLAS FIR — SAMPLE No. 3681 — PROJECT No. 228-2

Tests to Determine the Effect of Pitch Pockets on the Strength of AIRPLANE Wing Beams

Static Bending — Third Point Loading — 72" Span

Sticks whose numbers are followed by "P" have pitch pockets and are matched to obtain fibs from pitch pockets which have the same number except for a letter. Numbers of failure denote order in which failure occurred.

Pitch Pockets in Beams for Various Method Tests were eliminated in reading.

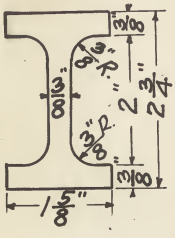
Fig. 2- Pitch Pockets on Lower Tension Side Within Third of Span

AIRPLANE WING BEAMS

These wing beams were tested by the third point loading method illustrated in the preceding photograph.

DOUGLAS FIR — SAMPLE Nº 3681 — PROJECT Nº 228-2

TESTS TO DETERMINE THE EFFECT OF PITCH POCKETS ON THE STRENGTH OF AIRPLANE WING BEAMS.



Static Bending — Third Point Loading — 72" Span. Sticks whose numbers are followed by "P" have pitch pockets and are matched to sticks free from pitch pockets which have the same number without a letter. Numbers at failures indicate order in which failures occurred.

Pitch Pockets in blanks for beams marked thus * were eliminated in routing.

Group III – Pitch Pockets in lower flange and center third of span

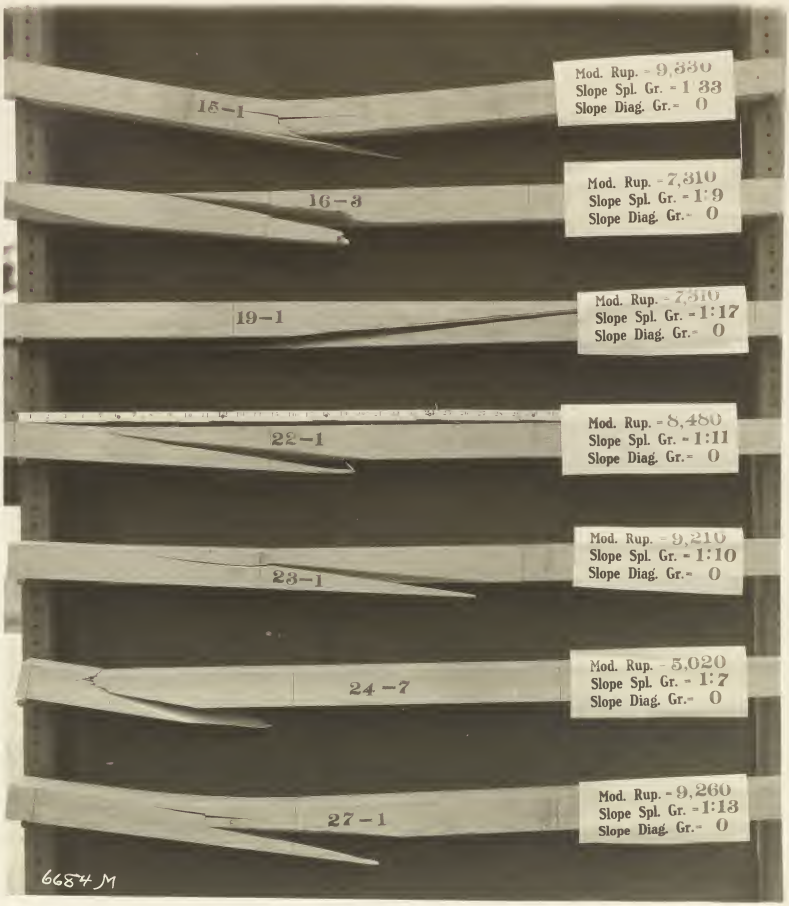
6386 M

SITKA SPRUCE – SHIPMENT No. 877

Tests to determine the effect of normal and diagonal

CROSS GRAIN AIRPLANE MATERIAL

Knowledge of the effect of spiral and diagonal grain is important in determining the allowable defects in airplane material. The laboratory is making extensive investigations in this field in order that the supply of suitable material may be enlarged as far as possible.



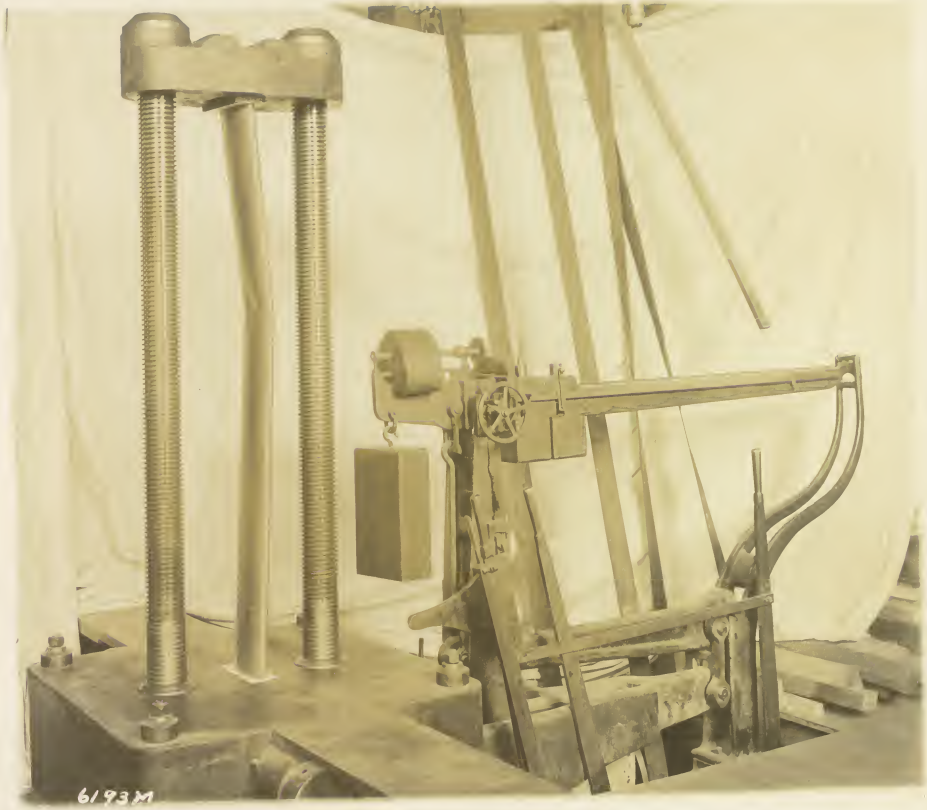
SITKA SPRUCE – SHIPMENT No. 577

TESTS TO DETERMINE THE EFFECT OF SPIRAL AND DIAGONAL GRAIN ON THE STRENGTH PROPERTIES OF WOOD. (PROJ. 228–4)

STATIC BENDING – THIRD POINT LOADING – 45" SPAN.

COLUMN BENDING TEST

The specimen shown is a gum veneer strut.


6193M

MANNER OF FAILURE OF DOUGLAS FIR

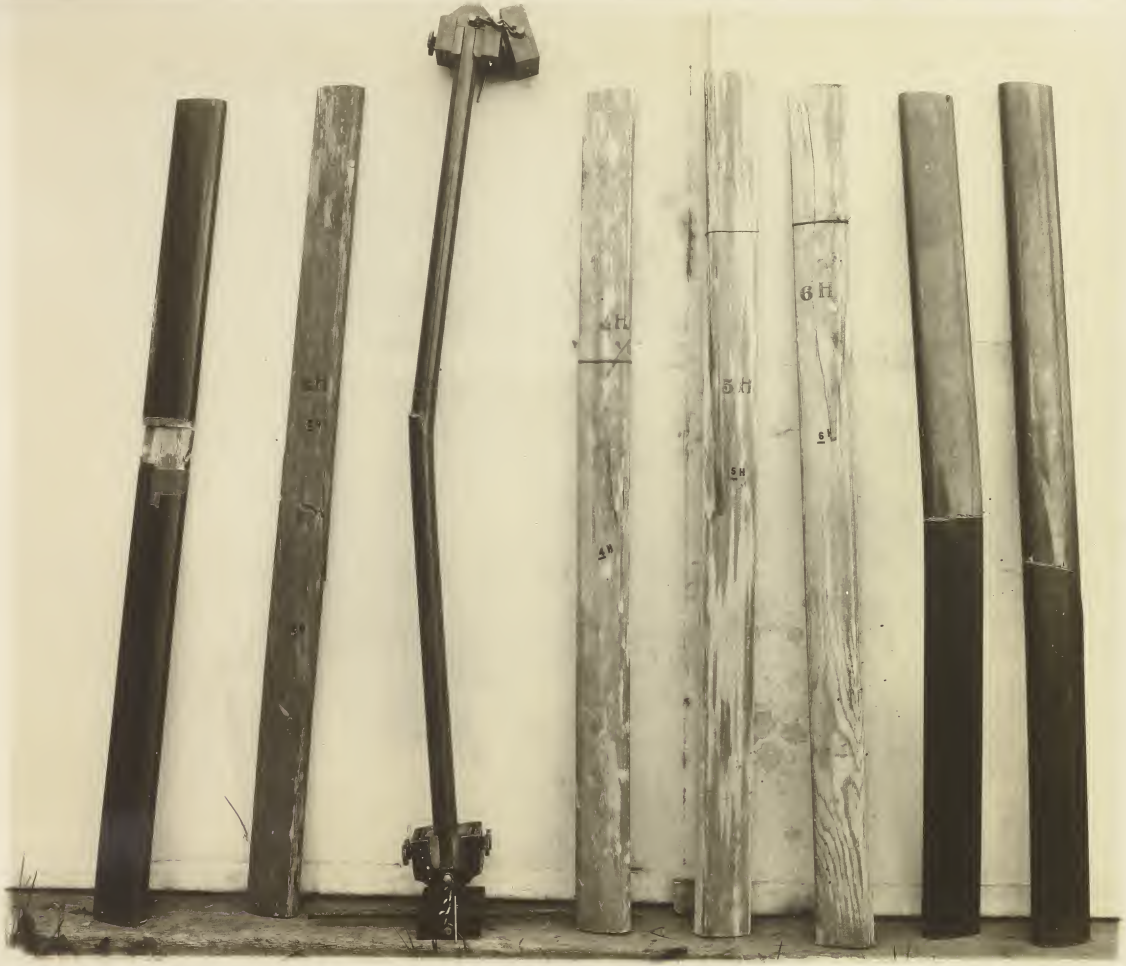
DH-4 STRUTS

Numbers 9-11 were tested with knife edge fittings at the end. Numbers 8 and 12 were tested with regular end fittings.


7°F
6°F
8°F
10°F
11°F
12°F
6621M

STRUTS TESTED IN COLUMN BENDING APPARATUS

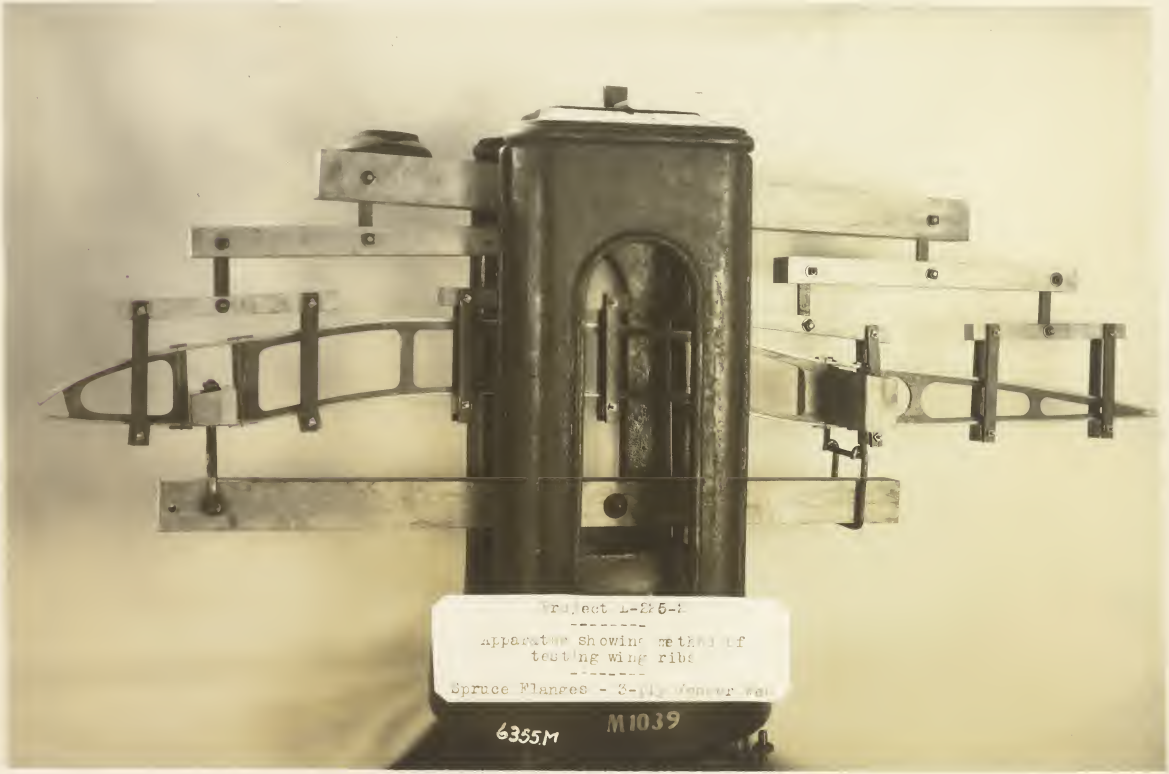
These specimens were of somewhat inferior spruce covered with bakelized canvas to determine whether such material would add the necessary reinforcement.


4H
5H
6H

12

SPECIAL LOADING APPARATUS
FOR WING RIB TESTS

This apparatus was devised at the laboratory to simulate the stresses to which an airplane wing rib is subjected in actual flight. The load is divided into eight zones, and the design of the wing rib in each zone is altered if the data shows that that section is weaker or stronger than the requirement.


Project L-226-1

Apparatus Showing method of
testing wing ribs

Spruce Flanges - 3-ply Veneer web
6355M
M1039

EVOLUTION OF WING RIB TYPES

The first two wing ribs were submitted by an airplane company and tested at the Laboratory. The results of tests suggested variations in design embodied in the other four ribs. The marked improvement in strength is indicated in the data sheets at the side.

Project 22b-2

Forest Products Laboratory

Madison, Wisconsin May 27, 1918.

NOW AN EXPERIMENTAL PLANT

This building was formerly occupied by the Soils Department of the College of Agriculture, University of Wisconsin. In the present emergency it has been given over to the Forest Products Laboratory for experimental work in the manufacture and conditioning of airplane propellers.

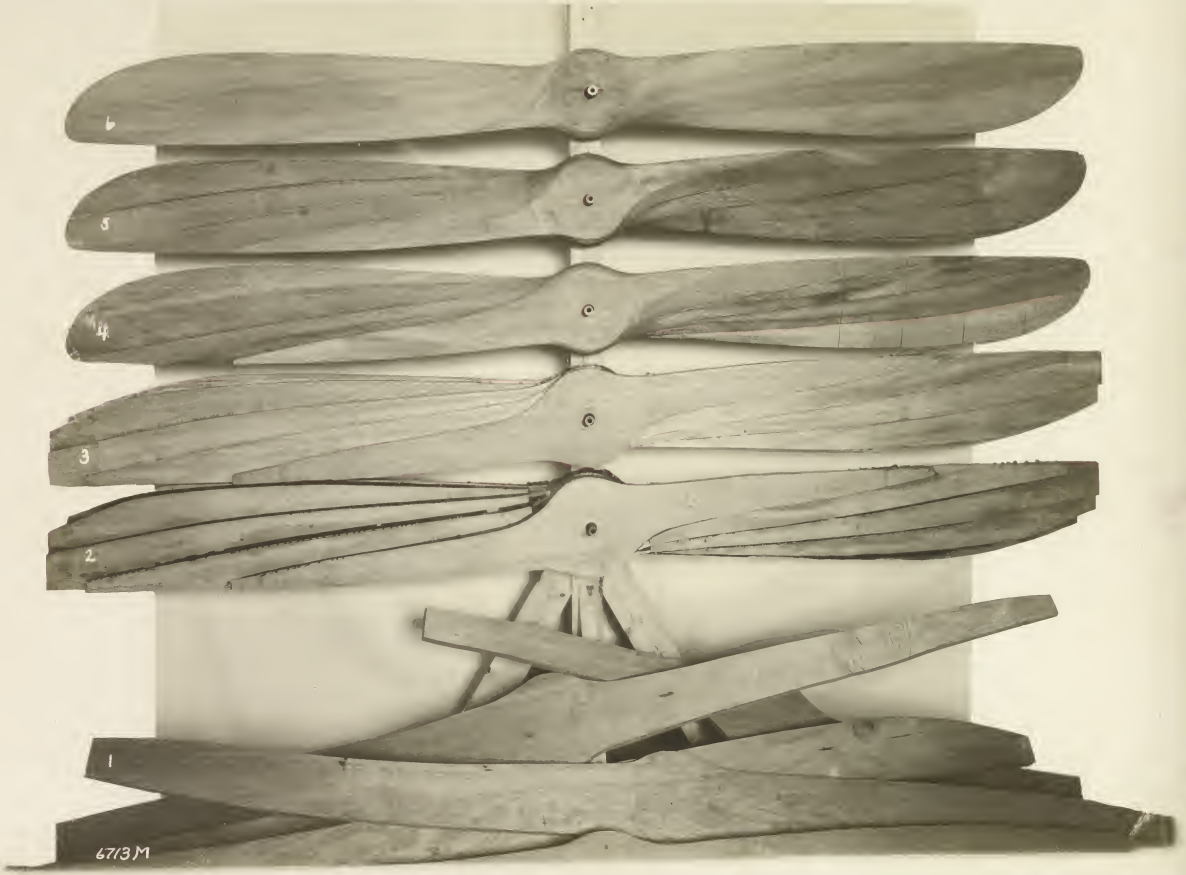

6714 M

15

APPEARANCE OF AIRPLANE PROPELLERS
AT DIFFERENT STAGES IN THE
MANUFACTURING PROCESS

1 - The five laminations ready for gluing.
2 - Propeller as it comes from the glue clamps.
3 - Excess glue scraped off.
4 - Sawed to shape and corners roughed off.
5 - Dressed to within 1/8" of finished size
in which condition it is stored for
several weeks
6 - Finished to size and ready for varnish.

These particular propellers are true mahogany.


6
5
4
3
2
1
6713M

PROPELLERS WITH METAL LEAF COATING

Two plain-sawed red oak airplane propellers coated with aluminum leaf by a process developed at the Forest Products Laboratory, and now undergoing practical tests. This covering is followed by others of enamel and varnish. The metal leaf coating is practically impervious to moisture, and therefore does away with the harmful swelling or shrinking which takes place in the propeller with changes of moisture content.

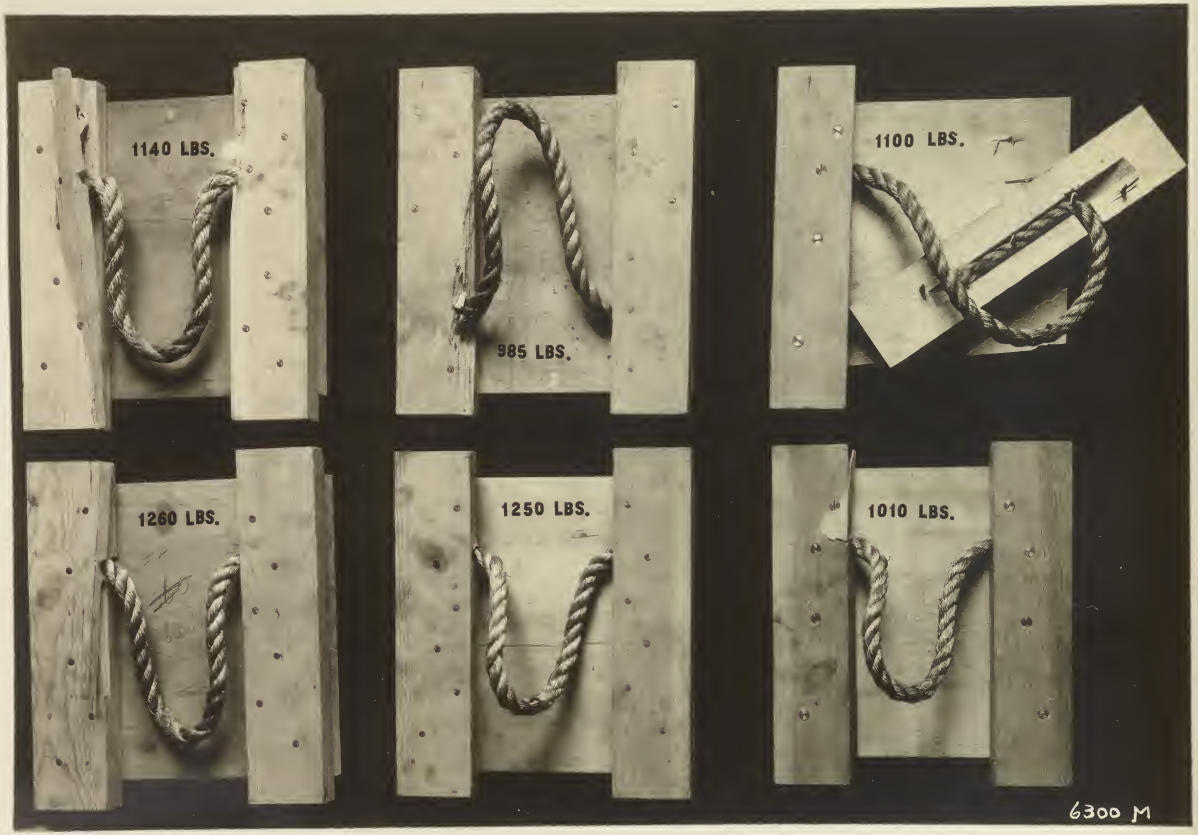
BOX TESTING MACHINE

This machine is being used to test the efficiency of various types of boxes for transportation of army supplies over seas. A box, loaded as for shipment, is placed in the hexagonal drum which is then turned by an electric motor. Six "hazards", one of which is visible in the photograph, are so arranged in the drum as to simulate the various shocks which the box might receive in transportation. Fifty drops in this machine may be regarded as equivalent to the punishment which a container receives in its journey to the front.

5 3/16

STUDY OF METHODS OF FASTENING
ROPE HANDLE CLEATS FOR
SHELL BOXES

In the Box Testing Department, not only is the construction of the box proper studied, but also the construction and serviceability of the handles by which it must be moved. In many cases, failure in this respect causes not only destruction of the box, but simultaneously physical injury to the workman.


1140 LBS.
985 LBS.
1100 LBS.
1260 LBS.
1250 LBS.
1010 LBS.
6300 M

SHEARING TEST FOR GLUES

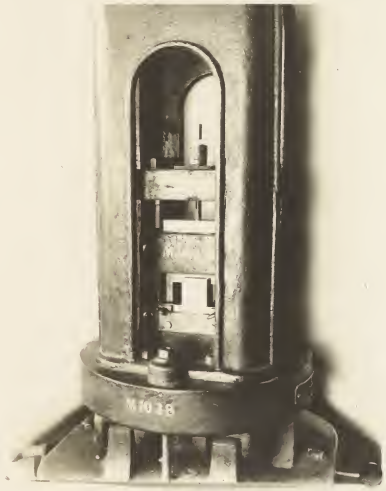
A - Shearing tool
B - Specimen consisting of two wooden blocks glued together, with a glue surface of four square inches.
C - Cross-section of tool with specimen in place.

This test was devised at the laboratory to obtain data on the shearing strength of glues which could be compared with that already obtained on the shearing strength of various woods.

SHEARING TEST FOR GLUES

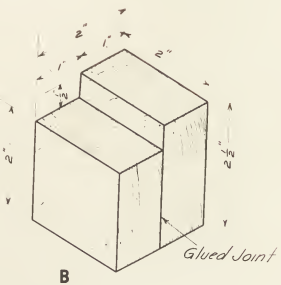
A - Shearing tool
B - Specimen consisting of two wooden blocks glued together, with a glue surface of four square inches.
C - Cross-section of tool with specimen in place.

This test was devised at the F.P. laboratory to obtain data on the shearing strength of glues which could be compared with that already obtained on the shearing strength of various woods.

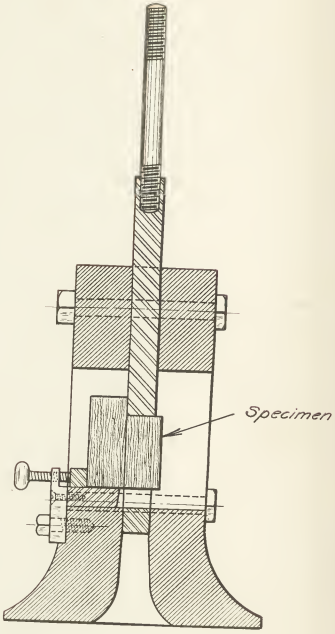


A

6239 M



B



C

FIG. 1.

ELEVATING LEVER TO ATTACH BRACE.

SPLITTING TESTS OF VENEER PANELS

The cone spear has an 8-inch taper and weighs 11.22 pounds. It is dropped from increasing heights upon the veneer specimen until failure occurs. The resistance of the material to splitting is called its "splitting energy". It is a measure of the resistance to splitting at the screw or bolt fastening of veneer panels.

6243M

Project L-225-1
Strength Tests of Veneer Panels

SPLITTING
Method of Test

STANLEY KENNEDY & SHIRLEY DUNLOP

Clothing and furnishing measurements are taken
on strict economic principles, after weighing
one test every vest, pant for these hours, and
after buying the material for the kind obtain-
ing one pet cent. Information of the kind is
of in the first is of value in selecting a vest
for strictest degree wears flat, multifarious
ties are fumofrant.

CUPPING AND TWISTING OF VENEER PANELS

Cupping and twisting measurements are taken on airplane veneer panel specimens, after wetting one face every half hour for three hours, and after drying the panel until the moisture is less than one per cent. Information of the kind obtained in this test is of value in selecting a panel for structural parts where flat, undistorted surfaces are important.

TWISTING

6375 M

CUPPING

Project L-225-1
Strength Tests of Veneer Panels

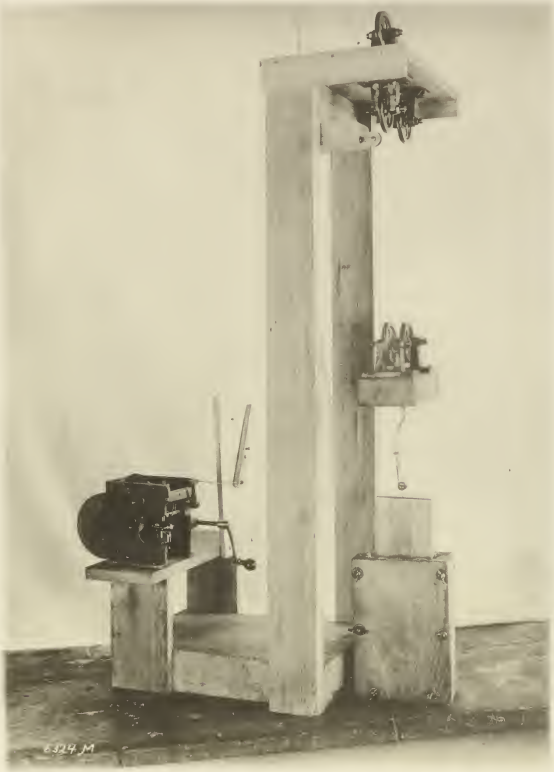
CUPPING AND TWISTING
Method of Measurement

Dusk Study

Dusk approaches in many ways
as does old age. Just
as with the fading of
daylight, we are
very aware of the approach
of darkness. We have
less control over
what is to come.
Very little
can be done
to stop
the
coming
of
darkness
and
night.

DIPPING MACHINE

This apparatus is used in applying coats of varnish to test panels. The panel is withdrawn from the dipping box very slowly so that an absolutely even coating results. This even coating is very necessary when testing the resistance of different varnishes and different number of coatings to deteriorating conditions.


6324 M

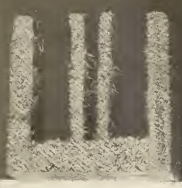
EXPERIMENTAL KILNS

One of the batteries of kilns at the Forest Products Laboratory. These kilns are used for experiments in the conditioning of woods for specific uses; e.g., airplane wing beams, struts, fuselage members, and propellers; army vehicle parts, gunstocks, shoe lasts, shuttles, patterns, etc.

6709M

KILN RUN SAMPLES

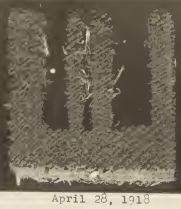
Taken for purpose of determining moisture content and observing signs of case-hardening, during one run on airplane material. Indicative of thoroughness required in experimental kiln drying.



April 27, 1918.

Average Moisture Content of Stock in Kiln - 38.4%

Moisture Distribution in Sample:
Inside - 32.7%
Outside - 24.6%
Difference - 8.1%



April 28, 1918

Average Moisture Content of Stock in Kiln - 37.3%

Moisture Distribution in Sample:
Inside - 29.9%
Outside - 24.0%
Difference - 5.9%

April 29, 1918.

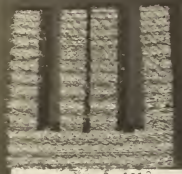
Average Moisture Content of Stock in Kiln - 32.6%

Moisture Distribution in Sample:
Inside - 29.1%
Outside - 16.8%
Difference - 12.3%

May 1, 1918.

Average Moisture Content of Stock in Kiln - 25.6%

Moisture Distribution in Sample:
Inside - 21.6%
Outside - 15.8%
Difference - 5.8%



May 2, 1918.

Average Moisture Content of Stock in Kiln - 22.5%

Moisture Distribution in Sample:
Inside - 18.1%
Outside - 15.2%
Difference - 2.9%

6682 M

May 3, 1918.

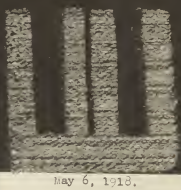
Average Moisture Content of Stock in Kiln - 20.2%

Moisture Distribution in Sample:
Inside - 17.8%
Outside - 13.4%
Difference - 4.4%

[illegible] 4, 1918.

Average Moisture Content of Stock in Kiln - 17.5%

Moisture Distribution in Sample:
Inside - 15.7%
Outside - 13.3%
Difference - 3.4%



May 6, 1918.

Average Moisture Content of Stock in Kiln - 14.2%

Moisture Distribution in Sample:
Inside - 11.1%
Outside - 9.6%
Difference - 1.5%

[illegible] 7, 1918.

Average Moisture Content of Stock in Kiln - 12.6%

Moisture Distribution in Sample:
Inside - 11.4%
Outside - 10.3%
Difference - 1.1%

Average Moisture Content of Stock in Kiln - 11.0%

Moisture Distribution in Sample:
Inside - 10.3%
Outside - 8.3%
Difference - 2.0%

Average Moisture Content of Stock in Kiln - 9.4%

Moisture Distribution in Sample:
Inside - 10.9%
Outside - 7.2%
Difference - 3.7%

Average Moisture Content of Stock in Kiln - 8.6%

Moisture Distribution in Sample:
Inside - 8.6%
Outside - 6.2%
Difference - 2.4%

VIN-DRIED KNITTED GOODS

Knits like leather inside. Material of extra chic stuff a delight at knitting to serve per cent during a depression period extending ordinarily even four or five years.

AIR-DRIED VEHICLE STOCK

Note the season checks. Material of this kind shows a degrade of twenty to thirty per cent during a conditioning period extending ordinarily over four or five years.

BATTERY OF COMMERCIAL KILNS

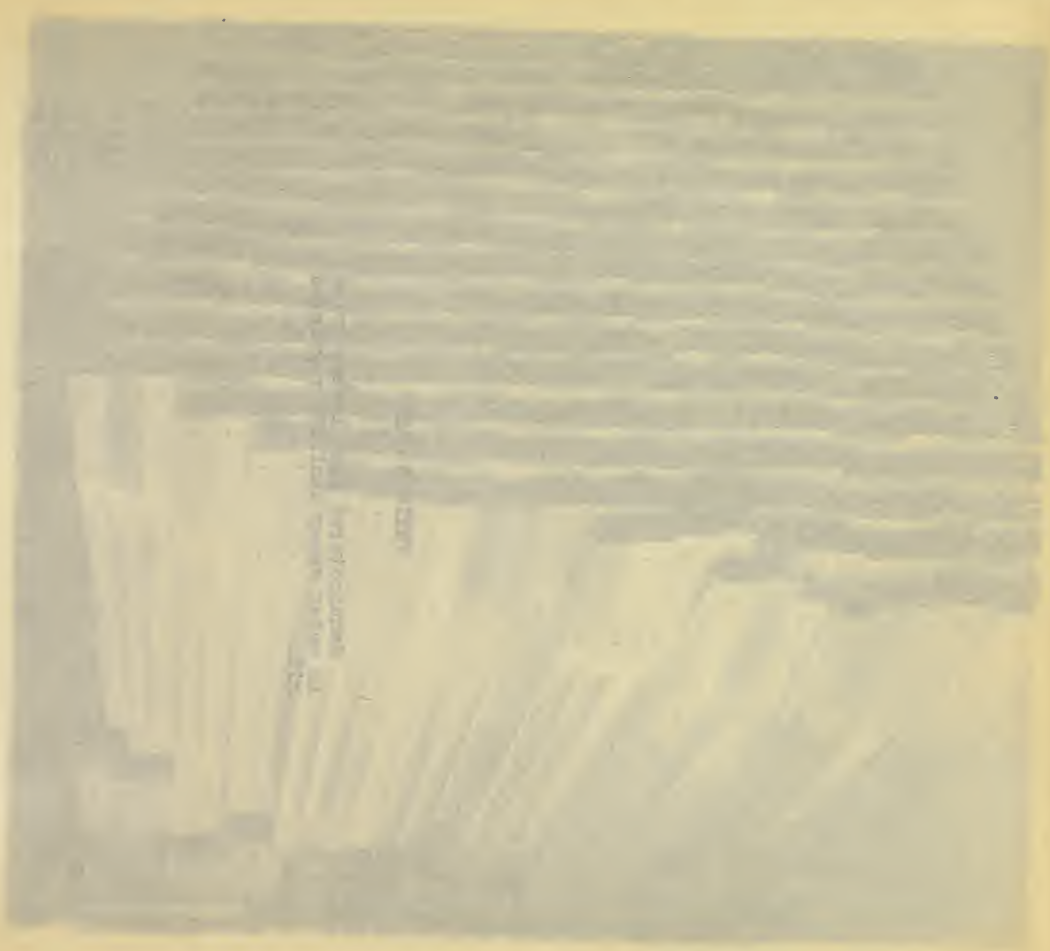
Operated by the water-spray humidity control method, developed at the Forest Products Laboratory. The axle beds shown in the following photograph were dried in these kilns.


N=3
6266M

WAGON STOCK PROPERLY KILN DRIED

These axle beds were dried in a water spray humidity regulated kiln. Their condition is perfect. Note end dip which is applied to prevent degrade at ends.

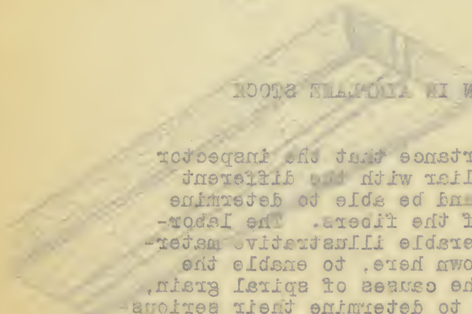

6436M

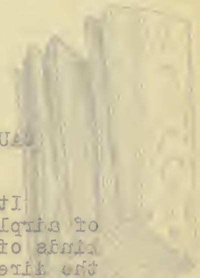


VEHICLE PARTS

Manufactured from lumber dried in water spray humidity regulated kiln.


6 4 4 4 M





CAUSES OF CROSS GRAIN IN AIRPLANE STOCK

It is of great importance that the inspector of airplane stock be familiar with the different kinds of "grain" in wood and be able to determine the direction and slope of the fibers. The laboratory has prepared considerable illustrative material, such as the plate shown here, to enable the inspector to understand the causes of spiral grain, diagonal grain, etc., and to determine their seriousness when they occur in stock offered for his inspection.

CAUSES OF CROSS GRAIN IN AIRPLANE STOCK

It is of great importance that the inspector of airplane stock be familiar with the different kinds of "grain" in wood and be able to determine the direction and slope of the fibers. The laboratory has prepared considerable illustrative material, such as the plate shown here, to enable the inspector to understand the causes of spiral grain, diagonal grain, etc., and to determine their seriousness when they occur in stock offered for his inspection.

FIG. 1

FIG. 2

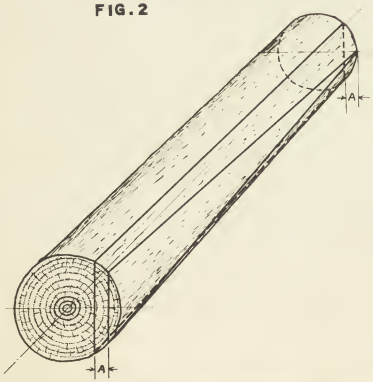


FIG. 3

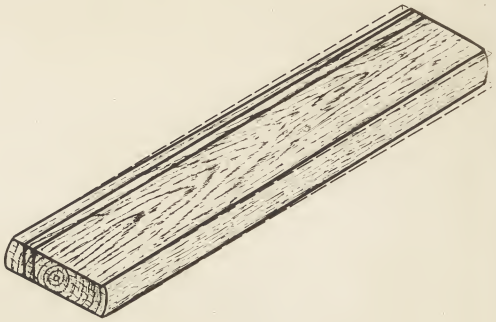


FIG. 4

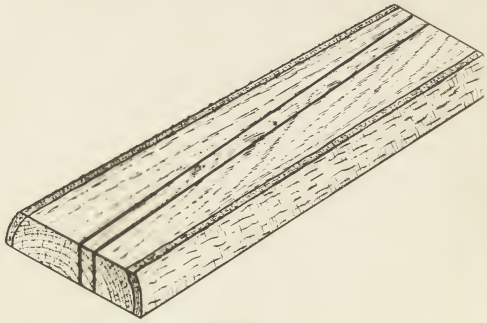


FIG. 5

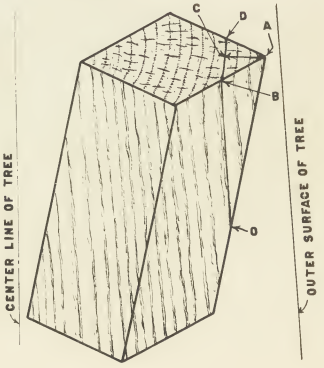
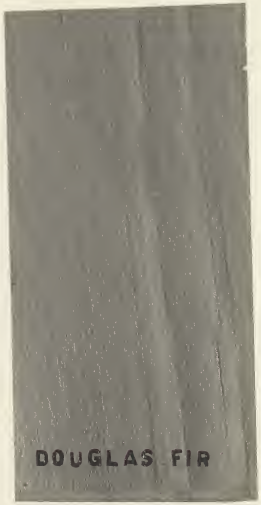


FIG. 6

HOW TO DISTINGUISH SITKA SPRUCE FROM DOUGLAS FIR

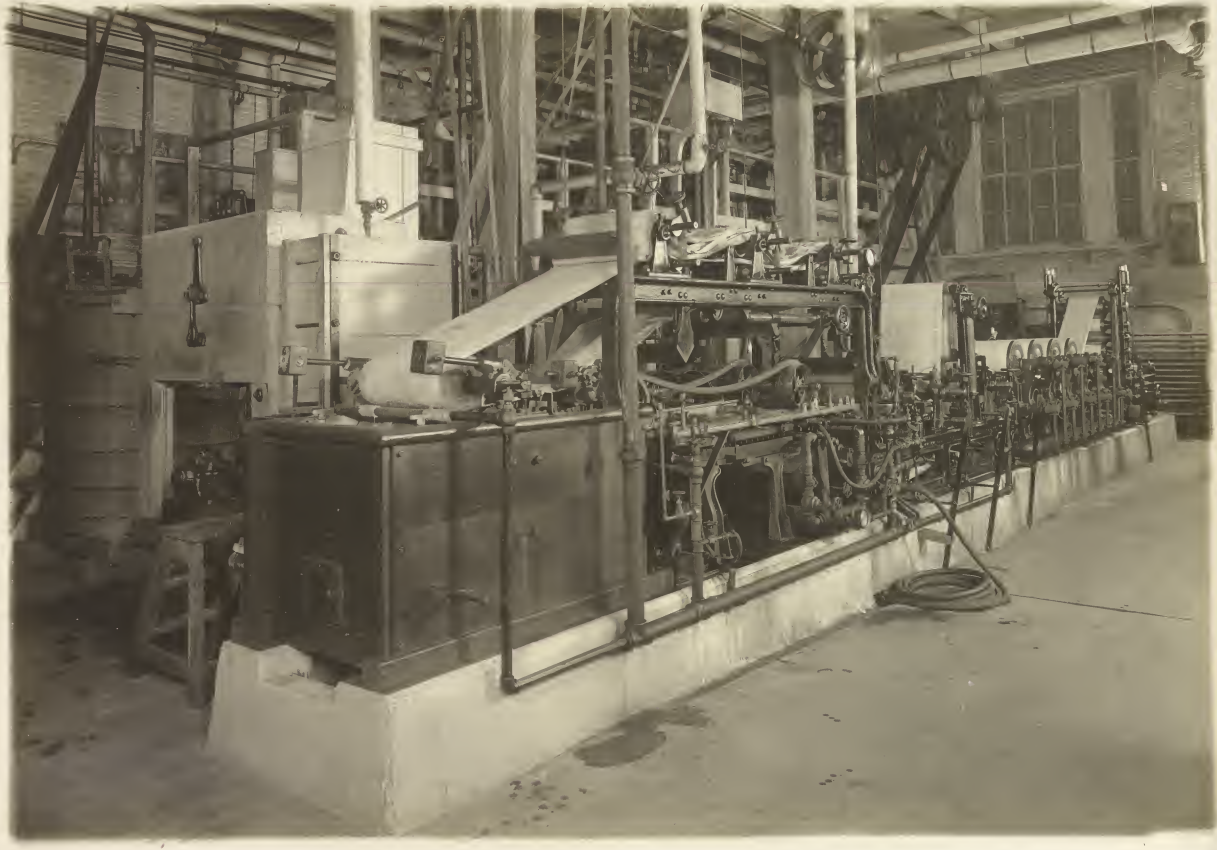
The laboratory is frequently called upon to aid in the identification of various species. At present there is a demand for a ready method of identifying Sitka spruce and Douglas fir, now used for similar purposes in airplane construction. The photograph shows a simple visual means which is usually sufficient to distinguish between these two species. The tangential or flat grain surfaces of both woods are shown. It will be noted that that of spruce has a pocked or dimpled appearance. This appearance is not found in Douglas fir.



6195M

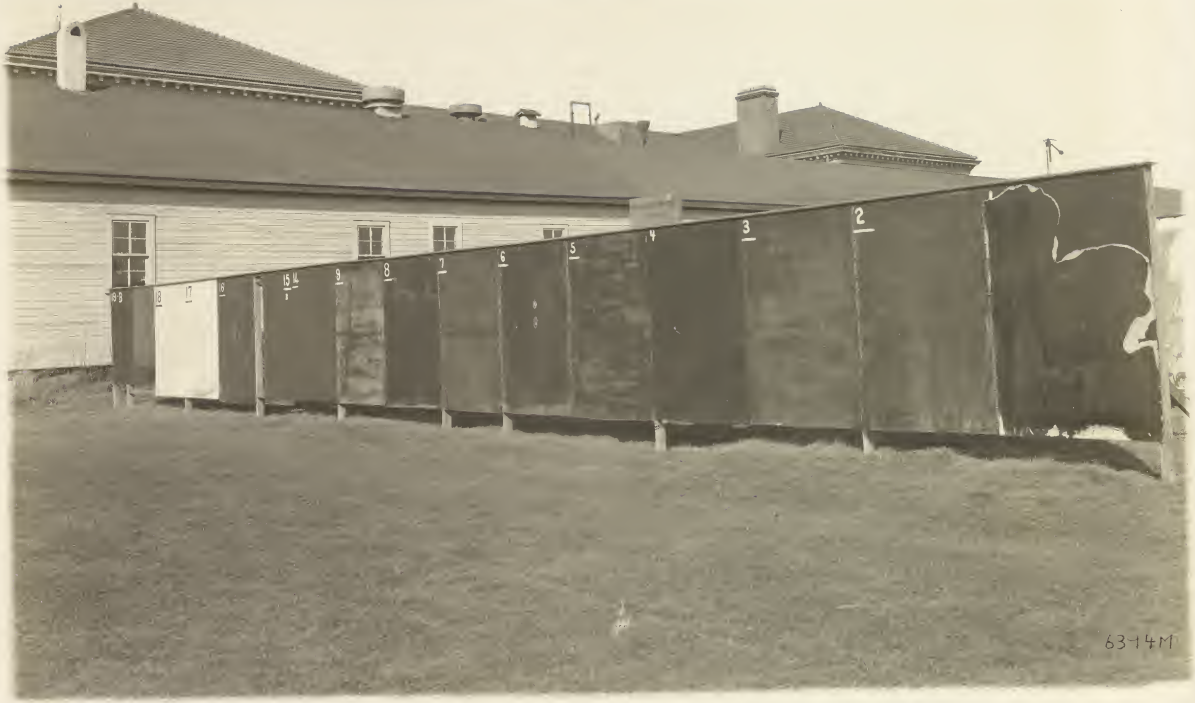
EXPERIMENTAL PAPER MACHINE

Used by the laboratory in determining the paper making possibilities of various forest materials.



THE LABORATORY TEST FENCE

Panels of commercial wall boards with various waterproof coatings exposed to weather to determine their suitability for portable airplane hangar construction.


63-14M

DISTILLATION EQUIPMENT

The laboratory is also thoroughly equipped for experimental work in the distillation of coal, whereby are produced, among other things, wood alcohol and acetone, which play an important role in the preparation of airplane wing dope.